NORTHEASTERN FOREST EXPERIMENT STATION

Division of Watershed Management Research

Semi-annual Report October 1957

GENERAL

The past 6 months have been marked by personnel changes, additional cooperative studies, and initiation of treatment at the Fernow watersheds. Calling the roll by Centers, our situation is about as follows:

Mountain State. Dick Trimble stepped into Sid Weitzman's shoes in July as Center Leader: they appear to fit. Treatment started in May on the 6-year calibrated watersheds. Cooperative watershed research with the Union Carbide Chemicals Company was made possible in a memorandum of understanding.

Kingston. The first weir was poured in our cooperative study with Penn State and the Department of Forests and Waters.

White Pine-Hardwood. Dick Sartz took over the Hubbard Brook project vice Trimble and Ray Leonard was added to staff. Also added: another weir and 2 miles of road.

Coastal-Oak Pine. Si Little et al prepared a paper describing the effect of waste water recharge on vegetation and soils, and possibilities of a study at the Bridgeport red-pine watersheds were considered.

Virginia-Pine Hardwood. Al Snow's Center developed a memorandum of understanding to conduct watershed research on the reservoir properties of Baltimore, Maryland.

We (editorially speaking) rarely comment on what we read in the semi-annual report (this is my first letter to your magazine) mostly because comments are hard to keep fresh for 6 months and are better handled by mail. But we would like to applaud Hoover's eloquent plea, in the last report, for a thoughtful, basic approach to watershed research. Here in the watery East (with less water available per capita than the arid West) we are not overly impressed by the argument that it takes 1,000 gallons of water to make a Coca Cola--therefore more watershed management research is necessary, nor does it occur to us that all our effort should go into the "how to" research even though efforts in other directions resist classification under the uniform project system. Water isn't our limiting resource, it's curious researchers.

Speaking of curious researchers, one of ours, Dick Sartz, hopes to make a trip West next spring to see what's going on, and pass on the secrets of Hubbard Brook.

KINGSTON RESEARCH CENTER

It was a great summer for foresters and resort owners in the Poconos. No rain, no insects interfered with the delights of field work, swimming, boating, and lolling.

Of course, it was pretty dry; some perennial streams and springs stopped flowing and at least one heavily-used recreational lake did not have much water in it. The Pocono Experimental Forest had the lowest monthly rainfall, slightly less than an inch in August. Dilldown had the lowest two-month total, 2.70 inches for July and August. Even so, it was oasitic in comparison to the desert-dry conditions south and east of the Poconos.

WATERSHED MANAGEMENT

Leading Ridge Watershed

With an absolute minimum of difficulty, the watershed study on Leading Ridge Watershed No. 1 is under way at State College, Pa. The fine all weather road allowed ready-mix concrete trucks to back right up to the weir site and chute their high-quality concrete right into the forms.

The apron was poured on July 16, the superstructure on July 26. On August 27, the wing walls were poured and the gage-house completed. The instruments were installed in the gage-house and weather station on September 19, and records began from that date.

Although the difficulties were at a minimum, there was a great amount of planning and perspiration involved. The Pennsylvania Department of Forests and Waters had all the materials delivered at the correct times. Mr. J. J. Malloy, of the U. S. Geological Survey and the Department of Forests and Waters in Harrisburg rendered invaluable advice on the design of the weir. The Penn State staff, Dick Byrnes, Dave Worley (now with the Forest Service in Beria, Kentucky) and the student assistants did most of the work at the site, and in an excellent manner. Ken Reinhart from the Mountain State Center helped with the planning and the superstructure pour. He was the only one on the job with previous weir construction experience; his advice and skill was most helpful. Gene McNamara, Art Eschner, and Irv Reigner assisted in the planning and construction, and gained valuable experience in weir-construction.

Although we do not have rainfall data for the summer months in the Leading Ridge area, it was dry. But the stream maintained a steady flow. We feel pretty certain that zero flow will never be experienced.

Watershed Calibration

Although interrupted much of the time by other activities, we were able to spend a fair amount of time on the calibration analysis.

A recent test of our ability to predict annual runoff turned out amazingly well. All estimates were within a few tenths of an inch of annual runoff-percentagewise almost infinitesimal.

Using runoff years beginning and ending with those months in which there was no snow storage, we found no difference between years beginning with various months. Surprisingly, our largest error was found in the yearly analysis beginning October 1. One year's estimate was 36.30 inches against 35.90 inches actual runoff. This was the largest error in any of the analyses.

The parameters used are:

1. Annual precipitation

2. Sum of temperatures over 30°F. Here we merely summed all maximum and minimum temperatures above 30°. Those temperatures below 31° were ignored.

3. Estimated storage change. Using our best equation to estimate storage, we estimated the storage at the beginning and end of each year. The difference, of course, is estimated storage change.

Using five years of record in each case, we analyzed those years beginning in May, June, July, August, September, and October.

One refinement in the prediction of monthly streamflow that removed a considerable amount of the previously unexplained variation is the use of a curved "correction" for large storms. One large storm contributes much more to current streamflow than several smaller storms of the same total rainfall. The smaller storms contribute more to storage gain.

As we have been using P-RO (which is storage gain plus evapotranspiration) as our dependent variable, we found that the 3/4 power of daily rainfall improved the relationship. A disadvantage of using an exponential form of daily rainfall is that it heavily weights all storms under one inch. Thus, a synthetic curve was devised using an arc of the circle beginning at zero.

For most of the range of the data, this is an unnecessary refinement. But in those months that have large daily rainfall figures, say four inches and above, the "corrected" figures are quite an improvement.

Another refinement is the grouping of months into categories of similar beginning storage, after it was found that the parameters differ depending on beginning storage. The categories are determined with a general equation estimating beginning storage. For example, in those months with very low storage, unweighted monthly rainfall is used with unweighted 100 day antecedent rainfall. But in the next group, low storage, a weighted expression of "corrected" daily rainfall is used for the monthly precipitation figure and for the antecedent precipitation figure. These two groups cover the months, July through November; the correlations are extremely high.

This, I hope will be our final progress report on single-watershed calibration. By Christmas we should have the results written up (a Christmas present for Upper Darby) and headed for publication.

Soil Moisture

Taking advantage of several root-raked patches on the Dilldown watershed Eschner has set up a soil moisture study under a number of vegetative cover conditions. These include bare root-raked soil, an area where the vegetation has been deadened but left intact, an area with ericaceous ground cover, one with a scrub oak cover, and one with a combination of scrub oak and ground cover. Several side problems have come up in connection with this study which have relieved the routine of soil moisture sampling. Bulk densities have been determined for the plots and estimates of the rock content of the soil are being obtained. In addition, a small study on the wilting point of the fibrous mor humus is underway.

Accumulating data show some obvious differences that appear to be reasonable and fairly consistent. Soil moisture under the deadened vegetation has remained the highest in all cases; that under a complete cover of scrub oak and ericaceous ground cover the lowest. Under a cover composed mostly of sheep laurel the soil moisture has been depleted almost to the point reached under the combined ground cover and scrub oak. In the scalped plots soil moisture has been moderately low and more variable owing probably to the rough surfaces and considerably lower infiltration rate.

Rock contents of the various plots were determined by digging regularly shaped pits, sieving out the rocks, weighing them and computing their volume using their specific gravity. The volume of the hole was estimated by packing it with a measured amount of sawdust.

Interception

This May a new phase of a continuing study on rainfall interception losses from scrub oak and northern hardwoods was begun at the Dilldown and Pocono forests. This study was designed to show whether there is any loss due to throughfall splashing out of the eaves trough previously used to collect rain in studies of this sort.

Miscellaneous

Eschner returned unscathed from the Northeastern Forest Soils Meeting in August in New Brunswick, Canada. This is no mean feat, considering the number of S.C.S. men present with their wicked looking knives.

Three Lull boys, Howard, David, and Miles, spent a week on the scenic Delaware-Lehigh Experimental Forest late in July. There they took soil moisture samples, measured humus depths and picked blueberries.

MOUNTAIN STATE RESEARCH CENTER

After no more backing and filling than might be expected, the decision was made to terminate the calibration period and start cutting in the gaged watersheds after six years of measurement. On May 13 (we're not superstitious) Carl Barr moved the bulldozer over the white-painted boundary line of Watershed No. 1 and the clearcutting practice on that watershed was underway. Results already are coming in: Water turbidity during first storm measured was 1800 ppm on clearcut; 12 ppm on control.

We are continuing our search for methods to clean up turbid streamflow. Reinhart visited the Engineer Research and Development Lab at Ft. Belvoir in May but found that their equipment, devised for other needs, is not adaptable for our purpose.

Gaging started on our two operated watersheds in time to welcome the New (hydrologic) Year. This makes nine watersheds we are gaging.

Soil Moisture Studies

Last year was a very wet year on the Fernow. There was relatively little change in soil moisture contents between the wettest and driest dates samples. This year is much drier and some of the moisture contents obtained probably approach the wilting point. Thus our sampling efforts are being better rewarded. So far, just one soil-moisture plot in the watershed being clearcut has been cut over. Initial inspection of the data shows that there is a decided difference between moisture contents of this plot and uncut plots.

We have made some preliminary analysis to determine soil moisture differences between opposing aspects and different positions on slopes. While the results are tentative, it appears that southwest aspects and upper slope positions are definitely drier than northeast aspects and lower slope positions.

Our experience this summer with gravimetric soil sampling has been disheartening because the only King tube points we could purchase recently have not stood up through more than a day of sampling. We sent

out a call for help to a number of Forest Service watershed workers and received many good suggestions from Marvin Hoover, Lou Metz, Ed Dortignac and Hubert Burke. We trust that we will be able to purchase satisfactory points from R. C. Jordan of Riverside, California. If their points are unsatisfactory, we will try some of the other suggestions offered.

Neutron Moisture Meter

Some progress has been made with the neutron moisture meter. Changes made in the meter to overcome earlier troubles resulted in voiding of the calibration curve supplied with the instrument. A new calibration curve has been prepared by relating meter readings to moisture content values determined from core samples in the relatively stone-free soils of the nursery bottom adjacent to the Fernow Forest office. Initial efforts made to install access tubes adjacent to the soil-moisture sampling plots in the gaged watersheds have been encouraging. We used van Bavel's method of pushing in the access tube a short distance, removing the soil from within the tube by use of an auger just slightly smaller in diameter than the tube itself. The King tube was also used inside the access tube to loosen the soil.

Reinhart visited Dick Marston at the Farmington Research Center in Utah just after this Center received a nuclear moisture meter manufactured by the Nuclear Instrument and Chemical Corporation of Chicago. This model, having built-in battery and trickle charger, appears in some respects to be easier and more convenient to use than the W. B. Johnson Associates' model. It also has a scaler or counter rather than a rate meter. It will be interesting to compare at a later date the performance of these two instruments.

Truck Road Seeding

A few years ago several miles of experimental logging truck roads were built on the Fernow to log four of our timber management compartments. Several stretches of steep grade were incorporated in these roads to demonstrate problems encountered in using steep grade roads. The areas have been logged and the steeper grades (15-20%), even though well drained, began to erode very heavily this spring--thus fulfilling our expectations and making an excellent demonstration for logging operators of what they might expect of such roads.

To save our initial investment in these roads, which are needed for future logging operations and access to the area, we put in a number of new surface drains on the steep sections and then limed, fertilized and seeded them. The following seeding mixtures were used:

1. Chaff--40 bu./acre

or

2.	Timothy	- 10 lbs/acre
	Red top	- 10 lbs/acre
	Ky. 31 fescue	- 5 lbs/acre
	Domestic ryegrass	- 10 lbs/acre
	Total	35 lbs/acre

The roads were limed at the rate of a ton of lime per acre and 500 pounds of 10-10-10 fertilizer. In spite of the fact that they were not seeded until about August 5--which was in an extremely dry period--the seeding came through in great style and we are assured that our roads are "saved". For about $200 we saved probably $2,000 in road investment money. This demonstration of what happens to steep grades and how to prevent disastrous washing on logging roads is selling a lot of good logging road practices in this area.

Cooperative research

High-light of a recent Advisory Committee meeting was an announcement that the Union Carbide Chemicals Company and the Mountain State Research Center have entered into an agreement to do research in southern West Virginia. This work will be centered at a new 2,500 acre experimental forest established on Company land near Charleston, West Virginia. Plans are now underway by both organizations for initiation of early studies on this area. Work on the new experimental forest will serve two special purposes. One--do research under the conditions found in southern West Virginia of which the Fernow is not strictly typical; and two--provide a center of research and demonstration for the numerous foresters employed in the southern West Virginia area. At present their location at a considerable distance from the Fernow handicaps them in following closely the results of Fernow research. Studies will be made on this area in the fields of timber management and watershed management, and both will be tied into wildlife management.

Streamflow computations

After studying ARS instructions, running sample computations, and considerable discussion, Ken Reinhart has come up with four changes in our methods of computing streamflow. We would like your comments on these.

1. Mark times and gage-heights on charts.

This information is then written down twice, on chart and on Form 6. However, this disadvantage is offset by the advantages. Reading of charts and checking the operation will be facilitated because all the work is on one piece of paper. Once the times and stage heights are written on the chart, the remaining job is a clerical one. As soon as the charts are marked and tabulated, they can be booked using Acco fasteners and simple manila covers. This will avoid confusing shuffling and sorting of charts.

2. For each weir, prepare new table of rating factors based on (a) present discharge table, (b) conversion from minutes to seconds, and (c) conversion factor accounting for area of watershed.

This factor would be entered on Form 6 in column for discharge rate. Multiplication of the factor by number of minutes in the time interval and dividing by 1,000 gives c.s.m. for the day. Area runoff (accumulated) in cu. ft. would be omitted. For maximum peaks, factor is multiplied by 1.44.

Values for each stage height are determined as follows: c.f.s. from discharge table X 60 X area factor for watershed. Setting this constant in the calculator, the table can be built up rapidly by multiplying by the values in the discharge table.

It will, of course, take some time to prepare the tables. However, the more simplified computation involved and the elimination of recording the accumulated cubic feet for the day (which has not yet been used for any specific purpose) should make such tables worthwhile.

3. In entering c.s.m. for the day and for maximum peaks, carry to 3 decimal places instead of 4 places as is now being done.

In testing this, the six month total discharge in area inches of water by the original method was 17.9253; by the "rounding" method, it was 17.926 or 17.9257. In analysis so far, annual totals of area inches have been used to 2 decimal places only. Thus it seems clear that 3 decimal places are sufficient when entering c.s.m. for the day on Forms 6 and 7. This should make computation and checking of Forms 6, copying to Form 7, and computation on Form 7 a much easier job than heretofore.

4. In figuring maximum peaks only peaks with stage heights of 0.3 ft. and above be considered.

Currently, maximum peak values are being computed even for very small peaks resulting from small storms. In peak flow calibration analysis, the only peaks that have been considered are those of 10 c.s.m. and over (based on flow on the control watershed). Perhaps in future analyses, smaller peaks will be included but very small peaks probably never will be considered. A value of 5 c.s.m. seems a logical lower limit.

In setting a dividing line for computation of peaks, a rule based on stage height is the most logical. It will also be simpler if the same rule can be applied to all watersheds. A peak of 5 c.s.m. at Watershed 2 (the smallest of the 5 watersheds) corresponds to a gage height of 0.333 feet. Stage heights for a peak of 5 c.s.m. at the larger watersheds are of course higher than at Watershed 2. For simplicity, it is recommended that peaks be tabulated and computed only when stage height is 0.300 feet or above.

Miscellaneous

Dick Trimble was transferred to Elkins as Research Center Leader effective July 1. Watershed soils man John J. Philips left for 6 months active military duty; his position is being capably filled by George Hart.

WHITE PINE-HARDWOOD RESEARCH CENTER

Our third, biggest, and most expensive weir to date is now in final stages of construction. It has a 120°, 2-foot V-notch with 4½-foot horizontal sections on either side; that is, a 2 foot V plus a 1½ by 16 foot horizontal section above the notch.

Like our other two weirs, this one has side walls. They extend at right angles to the cutoff wall for about 30 feet, then angle off into the bank. Depth of the pool at the notch with zero flow will be about 4½ feet.

The excavation proved to be a larger part of the job than we anticipated. After bulldozer excavation last summer it looked like a few days of hand work would expose solid ledge in the whole basin and that would be that. Not so. The ledge was not only very irregular, but it consisted of loose layer upon layer, with water and mud oozing out between the layers. Not knowing whether the loose layers were concealing water-porous seams or not, we had to keep peeling them off--ton after ton--by means of crow-bar, strong back, and the winch on our new Power Wagon. But now we have what we feel confident is a water-tight basin--solid ledge with all walls keyed into it.

The watershed above it is 95 acres--3 times the size of our other two.

For intake pipes on this weir we used 3-inch solid Orangeburg pipe instead of galvanized steel pipe. Orangeburg is an asphaltum covered fiber pipe. It is very light and can be sawed to length on the job, yet it is strong enough to use as an intake, if not subject to freezing.

Having built three ourselves, we now feel that we can contract construction on future weirs. The contracts will have to be on a per yard of excavation and per yard of concrete basis and will have to permit flexibility of design. Contract jobs will, of course, require close inspection, but they will tie up only one of our regular staff full time instead of practically everybody.

Calibration problems

Here at Hubbard Brook it is our practice to build prototype weirs. We calibrate them volumetrically at those flows low enough to do this, and use the formula values for higher flows. We have found, however, that volumetric calibration has its problems too. Having tried various sizes and shapes of calibration troughs that clamped to the blade, we have yet to find one that doesn't cause drawdown at certain flows. Apparently the trough eliminates free fall at certain flows, and drawdown results. Our latest, but as yet untried scheme, is a trough bolted and sealed (with asphalt) to the concrete trough below the V-blade. This will not interfere with flows over the blade in any way. If someone has a simpler way we would be happy to hear of it.

A real road at last

Having struggled through almost three years of operation on the Hubbard Brook Experimental Forest with an ancient, and beat-up logging road as our only means of access, our just-finished, permanent, all-weather forest road seems a real luxury. This first section of 1.8 miles brings us to our present area of operation, and construction is now under way on another section that will take us 1.8 miles farther into the watershed. We struggle on, but more comfortably now.

"Nor any drop..."

We have just been through--and are still in--an extremely dry season. Rainfall from July 8 to September 20 has been only 3.47 inches and from August 1 only .65 inches. Both of our operating weirs have yielded no flow for about a month. These are on 32- and 33-acre watersheds. The flow on 95-acre watershed

No. 3 was down to a mere trickle before a recent 0.5 inch rain. Fortunately, we had enough water for mixing cement, but not enough to interfere with pouring operations. Did someone say "good planning"?

Despite the dry weather, grass seeding of our weir sites and spur road in July produced a heavy cover. We used a mixture of orchard grass, red top, and creeping red fescue along with lime and 10-10-10 fertilizer.

Wanted: Design for a tilted windshield baffle

Is it necessary to tilt precip gages for efficient catch on the HBEF? Are windshields necessary? If the answer to both questions is "Yes", should we use horizontal or tilted windshields? We have set up a small study to find out.

Having accepted results from San Dimas and elsewhere as being generally applicable, it has been our practice to use tilted gages and windshields. But because standard windshield designs are all for horizontally mounted shields, that is what we are using. According to Helmers' Priest River study, tilted shields are much superior. If this is true here, we should be using them.

Our study will consist of 3 gages in one opening. All are standard, 8-inch gages. One will be tilted with a tilted shield; one will be tilted with a horizontal shield; and one will be horizontal with a horizontal shield. All shields will be of the same design; they will differ only in the mounting arrangement.

The gages will be operated for one or two years with the shields. Then the shields will be removed from the two gages that had the least catch, and measurements continued for another period long enough to establish differences in catch.

If the tilted gage and shield combination is found to give the greatest catch, we will adopt this as standard practice. If it is not, we will extend the study to other sites before deciding on a standard practice.

We have not yet completed installing this study because we have been awaiting experienced advice on the design of a tilted windshield. If any reader has a good one, we'd appreciate hearing about it.

Snow scales again

We noted with interest Bert Goodell's comments in the last semi-annual on the "Northeastern's" steelyard, the one that CAL Station originated. Checking with Chatillon about Bert's $90, one-tenth-inch Frazer Special (we were curious because we had been

quoted $175 for the same scale) it turned out that the price is $90 indeed, but without the backstart. So what backstart is worth $85? We ordered one.

We still wouldn't give up the steelyard. We use it in calibrating our weirs; we use it to check the inexpensive ($9) milk scales that we use to weigh our precip gages in the winter; and we'll have it to check our Frazer Special when we feel that the springs may be weakening.

Personnel and general

It's now Dr. Pierce. Bob spent the month of May at Madison, Wisconsin taking care of the final requirements for his Ph.D. in Soils, and was awarded the degree at this commencement. His thesis is titled, "Ground water, its nature, properties, and effects on forest growth."

Sartz moved up to Trimble's job in July, and Pierce to the assistant project leader spot vacated by Sartz. In the meantime, Raymond E. Leonard of Burlington, Vermont has been hired to round out the organization. He reported for duty on June 10. Ray comes to us from the staff of the University of Vermont. He is a graduate of Paul Smiths ranger school and the University of Vermont, and holds a Master's degree from the University of Helsinki.

Sartz and Pierce attended the Northeastern Forest Soils Conference in New Brunswick the week of August 18. The Canadians had planned an extremely interesting tour, and were otherwise most congenial hosts. Their scheme for evaluating site by classifying local climate (warmer than normal, normal, or cooler than normal) is thought-provoking. If only they had some data!

We conducted a show-me-trip at Hubbard Brook installations for a group of University of New Hampshire students under Dr. Harold Harker on July 19. We were accompanied by Mr. A. Saiyeh, Chief Forester of Liberia, and Mr. Fred Beane, Jr., correspondent for the New Hampshire Sunday News. Mr. Beane turned out a nice two-installment write-up with 6 pictures on the project. It appeared in the September 1 and 8 issues.

COASTAL OAK-PINE RESEARCH CENTER

The effect of spraying 600 inches of waste water a year (for the past 6 years) on vegetation and soils on the Coastal Plain of New Jersey is described in a paper submitted by Si Little, Howard Lull, and Irwin Remson (Geological Survey). Much of the natural vegetation was killed by the spraying. In its place has developed a rank growth of elder and many herbs--mostly pokeberry and weeds, as the smartweed. The forest floor is deeper and more mull-like than the unsprayed areas and has a much

greater earthworm population. The top 6-inch layer of soil in sprayed areas contained more organic matter and much more soluble nitrogen and phosphorus than the check areas. High rates of water absorption on the sprayed areas are associated with forest growth to the extent that it indicates an undisturbed soil condition and provides a protective forest floor to break the impact of the spray.

In mid-August, Horace Somes and Howard Lull visited the Newark, New Jersey and Bridgeport, Connecticut municipal watersheds. At the latter, a severe Matsucoccus scale is rapidly killing off sizable plantations of red pine. Possibilities of a study with the Division of Forest Insects were discussed with Phil Dowden to determine the effect of this infestation on water relations.

VIRGINIA PINE-HARDWOOD

This Center picked up a watershed project in September with the signing of a memorandum of understanding with the Bureau of Water Supply, Baltimore, Maryland and the Maryland Department of Forests and Parks. An experimental area containing four small watersheds was selected; we expect that two weirs will be built this year. A soil survey has been made of the area. Bernie Frank, Dick Trimble, and Ken Reinhart have served as consultants and advisors.

PUBLICATIONS

Physical properties of 134 soils in six northeastern states. A. R. Eschner, B. O. Jones, and R. C. Moyle. Northeastern Forest Exp. Sta. Paper 89. 11 pp., illus.

Forests guard the Potomac. Howard W. Lull and Ralph W. Marquis. Interstate Commission on the Potomac River Basin. 19 pp., illus.

How far from a stream should a logging road be located? George R. Trimble, Jr., and Richard S. Sartz. Jour. Forestry 55: 339-341.

A program of watershed-management research on forest lands in the upper Delaware and Susquehanna River basins. Howard W. Lull and Irwin C. Reigner. Northeastern Forest Exp. Sta. Paper 92. 33 pp., illus.

Snow and frost measurements in a watershed management research program. Richard S. Sartz. Northeastern Forest Exp. Sta. Paper 96. 9 pp., illus.

Forest watershed management research in Pennsylvania. Howard W. Lull. Pa. Forests 37: 41-42.

Manuscripts submitted

Influence of land use on time of soil freezing and thawing in the northeast. Richard S. Sartz.

Logging road seeding for erosion control in the White Mountains. J. C. Bjorkbom and G. R. Trimble, Jr.

The effect of type of soil frost on infiltration. G. R. Trimble, Jr., R. S. Sartz and R. S. Pierce.

Forest cutting and floods: early beliefs in Pennsylvania. Howard W. Lull.

A soil survey of forest land on the Hubbard Brook Experimental Forest. L. E. Garland, R. S. Pierce and G. R. Trimble, Jr.

Changes in woodland vegetation and soils from spraying large amounts of waste water. S. Little, H. W. Lull, and I. Remson.

A problem analysis and program of research for forest watershed management research in the White Mountains of New England. G. R. Trimble, Jr.

Calibration of five small forested watersheds. K. G. Reinhart.